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CROSS-COUNTRY EMPIRICAL EVIDENCE ON THE MACROECONOMIC EFFECTS OF CARBON PRICING: A META-ANALYTIC REVIEW WITH SIMULATION FOR RUSSIA

Research article

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Abstract

This article presents a systematic review and narrative synthesis of empirical studies estimating the macroeconomic effects of carbon pricing on GDP. While existing meta-analyses have focused exclusively on emissions reductions, no prior work has synthesized evidence on GDP effects across methods and jurisdictions. Drawing on ten empirical investigations published between 2012 and 2024, we identify a fundamental divergence: carbon taxes show no statistically significant negative effect on GDP when revenues are recycled through reductions in distortionary taxes, whereas cap-and-trade systems (particularly the EU ETS) are associated with GDP declines of approximately 0,3 percent following restrictive carbon policy shocks. Revenue recycling emerges as the single most important moderator, reducing the negative GDP impact by 50 percent or more across all settings where it has been studied. We develop and calibrate a simple heterogeneous elasticity model linking GDP–carbon price elasticity to measurable structural characteristics of the economy. Using this model and open-source data from the World Bank, OECD, and IEA, we conduct scenario simulations for the Russian Federation — one of the largest economies without comprehensive carbon pricing and the world's fourth-largest CO_2 emitter as of 2022. Russia's structural characteristics (energy intensity of approximately 8,5 MJ per dollar of GDP, renewable energy share of 3,5 percent) imply an estimated GDP elasticity approximately twice the average for countries with existing carbon pricing. At a carbon price of 50 USD per ton of CO_2, the projected short-run GDP impact ranges from minus 0,4 to minus 0,5 percent with revenue recycling to minus 0,8 to minus 1,0 percent without recycling, consistent with independent computable general equilibrium estimates for Russia.

Keywords: carbon pricing, GDP elasticity, revenue recycling, climate policy, carbon-intensive economy.

МЕЖСТРАНОВЫЕ ЭМПИРИЧЕСКИЕ ДАННЫЕ О МАКРОЭКОНОМИЧЕСКИХ ПОСЛЕДСТВИЯХ ЦЕНООБРАЗОВАНИЯ НА УГЛЕРОД: МЕТА-АНАЛИТИЧЕСКИЙ ОБЗОР С МОДЕЛИРОВАНИЕМ ДЛЯ РОССИИ

Научная статья

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Аннотация

В данной статье представлен систематический обзор и нарративный синтез эмпирических исследований, оценивающих макроэкономические последствия углеродного ценообразования для ВВП. В то время как существующие мета-анализы углеродного ценообразования сосредоточены исключительно на снижении выбросов, ни одна предшествующая работа не обобщала данные о влиянии на ВВП с учётом различий в методах и юрисдикциях. На основе десяти эмпирических исследований, опубликованных в период с 2012 по 2024 год, выявлена принципиальная дивергенция: углеродные налоги не оказывают статистически значимого отрицательного воздействия на ВВП при условии рециклирования доходов через снижение дисторционных налогов, тогда как системы торговли квотами на выбросы в частности, EU ETS ассоциируются со снижением ВВП приблизительно на 0,3 процента вследствие ограничительных шоков углеродной политики. Рециклирование доходов выступает наиболее значимым модерирующим фактором, снижающим негативное воздействие на ВВП на 50 и более процентов во всех изученных случаях. В работе разработана и калибрована простая модель гетерогенной эластичности, связывающая эластичность ВВП по цене углерода с измеримыми структурными характеристиками экономики. С использованием данной модели и открытых данных Всемирного банка, ОЭСР и МЭА проведено сценарное моделирование для Российской Федерации — одной из крупнейших экономик без комплексного углеродного ценообразования и четвёртого в мире эмитента CO_2

по состоянию на 2022 год. Структурные характеристики России (энергоёмкость приблизительно 8,5 МДж на доллар ВВП, доля возобновляемых источников энергии 3,5 процента) обусловливают расчётную эластичность ВВП по цене углерода приблизительно вдвое выше среднего значения для стран с действующим углеродным ценообразованием. При цене углерода 50 долларов США за тонну CO_2 прогнозируемое краткосрочное воздействие на ВВП составляет от минус 0,4 до минус 0,5 процента при рециклировании доходов и от минус 0,8 до минус 1,0 процента без рециклирования, что согласуется с независимыми оценками на основе вычислимых моделей общего равновесия для России.

Ключевые слова: углеродное ценообразование, эластичность ВВП, рециклирование доходов, климатическая политика, углеродоёмкая экономика.

Introduction

Carbon pricing mechanisms have become central instruments in global climate policy architecture. As of 2025, carbon taxes and emissions trading systems (ETS) operate in 47 national and 36 subnational jurisdictions, collectively covering approximately 23 percent of global greenhouse gas emissions — a dramatic expansion from merely 5 percent in 2010 [1]. This proliferation has generated urgent demand for empirical evidence on the macroeconomic consequences of carbon pricing, particularly its effects on aggregate economic output. Yet the empirical record presents a paradox: different methods and settings yield sharply divergent conclusions, ranging from statistically insignificant effects to GDP declines approaching one percent.

The divergence in findings is not merely a matter of statistical uncertainty. Metcalf and Stock [2], analyzing European carbon taxes using panel local projections across 31 countries over three decades, find positive but statistically insignificant effects on GDP growth, concluding that carbon taxes have not harmed economic performance. In contrast, Känzig [4], employing structural vector autoregression with high-frequency identification from 114 EU ETS regulatory events, documents significant GDP declines of approximately 0,3 percent following restrictive carbon policy shocks. In a joint study, Känzig and Konradt [5] explicitly reconcile this divergence, demonstrating that carbon taxes and emissions trading systems operate through fundamentally different economic channels — with revenue recycling, sectoral coverage, price volatility, and monetary policy interactions all contributing to the differential outcomes.

Despite the growing body of individual empirical studies, no prior work has systematically synthesized the evidence on GDP effects of carbon pricing. The most comprehensive existing meta-analysis synthesizes 80 studies and 483 effect sizes — but exclusively for emissions reductions, reporting 5 to 21 percent reductions across carbon pricing schemes [6]. Separate meta-analytic work addresses distributional impacts [7], and several narrative reviews survey the empirical landscape [8], [9]. The absence of a quantitative synthesis of GDP effects constitutes a significant gap in the literature, given that the primary policy concern regarding carbon pricing remains its potential impact on economic output and growth.

This paper makes four contributions. First, we present a systematic synthesis of empirical GDP estimates from ten studies employing diverse methodologies — local projections, structural vector autoregressions, vector autoregressions, difference-in-differences, panel econometrics, and computable general equilibrium models. Second, we identify the type of carbon pricing instrument and revenue recycling design as the key moderators explaining the divergence in findings. Third, we develop a simple heterogeneous elasticity model and use it, together with open-source data, to conduct scenario simulations for the Russian Federation — one of the largest economies without comprehensive carbon pricing and the world's fourth-largest CO_2 emitter as of 2022. Fourth, we formulate evidence-based policy recommendations for carbon-intensive economies.

Methods and Data

The analytical framework of this study comprises three components: a systematic review with narrative synthesis of existing empirical evidence, a simple model of heterogeneous GDP–carbon price elasticity, and a scenario simulation for the Russian Federation using open-source macroeconomic data.

For the review component, we identified empirical studies estimating the impact of carbon pricing on GDP, GDP growth, or aggregate economic output through a combination of targeted searches and citation network analysis. The initial pool of studies was assembled from recent comprehensive reviews of the carbon pricing literature [8], [9], [6], supplemented by forward and backward citation tracking through Google Scholar and NBER Working Papers. We included studies providing quantitative estimates of aggregate GDP or output effects — whether from econometric analysis of observed policy variation or from calibrated computable general equilibrium (CGE) models — and excluded purely theoretical models without calibration, studies measuring only emissions effects without GDP outcomes, and sectoral analyses without aggregate implications. This process yielded ten studies meeting the inclusion criteria. Given the heterogeneity of methods and the limited number of observations, we employ a structured narrative synthesis rather than formal meta-regression, systematically organizing estimates along four dimensions: instrument type (carbon tax versus ETS), estimation method, revenue recycling design (present or absent, and type), and time horizon (short-run versus long-run). Three additional studies providing complementary evidence on emissions effects [16] and firm-level outcomes [14], [15] are discussed in the text but excluded from the core GDP synthesis table due to differences in the outcome variable.

To translate the meta-analytic findings into projections for economies not yet covered by carbon pricing, we develop a simple model of heterogeneous GDP–carbon price elasticity. The model is motivated by the observation, consistent across the reviewed studies, that the macroeconomic impact of carbon pricing varies systematically with the structural characteristics of the economy — particularly energy intensity and the availability of low-carbon substitutes. Consider an economy where aggregate output Y depends on capital, labor, and energy, with energy composed of 'clean' and 'dirty' (carbon-intensive) inputs aggregated via a constant elasticity of substitution (CES) function. When a carbon price P_2c is introduced, the relative cost of dirty energy rises, inducing substitution toward clean energy. The magnitude of the output effect depends on the economy's carbon intensity, the ease of substitution, and the share of renewable energy in the energy balance. Following standard CES production theory [20], the GDP elasticity to carbon price can be approximated by a linear function of observable structural parameters in formula 1:

$$\varepsilon = \beta_0 + \beta_1 * \iota + \beta_2 * p, \quad [1]$$

where ε is the GDP elasticity to carbon price, ι is the energy intensity of the economy (MJ per dollar of GDP), and ρ is the share of renewable energy in total final energy consumption (percent). The coefficient β_1 captures the exposure channel: economies with higher energy intensity face larger cost shocks per unit of GDP from a given carbon price. The coefficient β_2 captures the substitution channel: economies with higher renewable energy shares have greater scope for shifting away from carbon-intensive inputs.

We calibrate this model using a cross-section of 47 jurisdictions with active carbon pricing mechanisms as of 2022. For each jurisdiction, the elasticity estimate is constructed by combining the GDP growth trajectory observed after carbon pricing introduction with the nominal carbon price level, using the local projection method of Metcalf and Stock [2] as the benchmark approach. Energy intensity and renewable energy share data are drawn from the World Bank WDI. Ordinary least squares estimation on this cross-section yields the following coefficients: β_0 = -0,028 (baseline elasticity for a hypothetical economy with zero energy intensity and zero RES share), β_1 = -0,0065 (each additional MJ per dollar of energy intensity increases the elasticity magnitude by 0,0065), and β_2 = +0,0008 (each additional percentage point of RES share reduces the elasticity magnitude by 0,0008). Both β_1 and β_2 are statistically significant at $p < 0{,}01$. The model has an R^2 of 0,41, indicating that energy intensity and renewable energy share jointly explain approximately 40 percent of the cross-jurisdictional variation in GDP — carbon price elasticity. The remaining variation is attributable to differences in policy design, institutional quality, and economic structure not captured by these two variables.

For the Russian simulation, we assemble structural indicators from six open-access databases. GDP per capita in purchasing power parity at constant 2021 international dollars, carbon intensity of GDP (kg CO_2e per 2021 PPP dollar), energy intensity (MJ per 2021 PPP dollar of GDP), renewable energy consumption as a share of total final energy consumption, trade openness, and industry value added as a share of GDP are all drawn from the World Bank World Development Indicators (WDI). Carbon pricing data come from the World Bank Carbon Pricing Dashboard (updated April 2025) and the ICAP Allowance Price Explorer. Effective carbon rates and carbon pricing scores for Russia are obtained from the OECD [22]. Historical ETS price series come from the Energy Institute Statistical Review of World Energy. Greenhouse gas emissions data are drawn from the IEA Greenhouse Gas Emissions from Energy Highlights database. We substitute Russia's current structural parameters into the calibrated model and project GDP impacts under three carbon price scenarios (25, 50, and 100 USD per ton of CO_2), each modeled with and without revenue recycling. The revenue recycling adjustment factor of approximately 50 percent is derived from the cross-study comparison in our review, based primarily on the findings of Goulder and Hafstead [10], Yamazaki [11], and Orlov and Grethe [18]. Scenario projections are presented as ranges rather than point estimates, triangulated against independent CGE results for Russia.

Results

Table 1 presents the core set of empirical estimates identified through our review, organized by estimation method and instrument type. The ten studies span a range of methodological approaches, geographic settings, and carbon pricing instruments, yet reveal a coherent pattern when examined along the dimensions of instrument design and revenue utilization.

Table 1 - Empirical Studies on GDP Effects of Carbon Pricing

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Study	Method	Sample	Type	Revenue recycling	GDP effect	Signif.
Metcalf, Stock (2020, 2023)	Panel LP	31 EU+ countries, 1985–2017	Tax	Various	+0,3 to +0,5 pp growth	n.s.
Känzig (2023)	SVAR	EU ETS, monthly	ETS	Limited	-0,3% GDP	***
Känzig, Konradt (2024)	SVAR + LP	EU countries	Both	Differential	ETS: decline; Tax: modest	** (ETS)
Bernard, Kichian (2021)	VAR	British Columbia, 2008–2017	Tax	Full (income tax cuts)	≈0	n.s.
Yamazaki (2017, 2022)	DiD	BC manufacturing	Tax	Full (income and corporate tax cuts)	-0,15% output; +0,06% TFP net	**
Goulder, Hafstead (2013, 2018)	E3 CGE	United States	Tax	Scenarios	-0,24% to -0,56%	Simul.
Makarov et al. (2020)	EPPA CGE	Russia (global policies)	Both	N/A	-0,5 pp growth/yr	Simul.

Study	Method	Sample	Type	Revenue recycling	GDP effect	Signif.
Orlov, Grethe (2012)	STAGE CGE	Russia (domestic tax)	Tax	Scenarios	-0,63% to positive	Simul.

*Note: LP = local projections; SVAR = structural vector autoregression; VAR = vector autoregression; DiD = difference-in-differences; CGE = computable general equilibrium. Significance: *** p < 0,01, ** p < 0,05, n.s. = not statistically significant, Simul. = simulation result. Metcalf and Stock [3] is a preliminary version; [2] is the full publication using the same data and method. Firm-level studies by Dechezleprêtre et al. [14] and Colmer et al. [15], and the emissions-focused panel by Best et al. [16], are discussed in the text as complementary evidence*

The most striking finding is the systematic divergence between carbon tax and ETS effects on GDP. All studies examining carbon taxes — Metcalf and Stock [2], Bernard and Kichian [13], and Yamazaki [11] — find either zero or positive GDP effects when revenue recycling is present. In British Columbia, where carbon tax revenues were returned through reductions in personal and corporate income taxes, two independent studies using different methods (VAR and difference-in-differences) converge on the conclusion that the tax had no discernible adverse macroeconomic impact. In a follow-up study, Yamazaki [12] further demonstrates that revenue recycling through tax cuts not only offset the gross output loss of 0,15 percent per year in manufacturing but reversed it to a net total factor productivity gain of 0,06 percent for the median plant. Metcalf and Stock [2], analyzing fifteen European carbon taxes, report point estimates that are positive (0,3 to 0,5 percentage points of GDP growth) though statistically insignificant, and explicitly conclude that they cannot reject the null hypothesis of zero growth effects over horizons of up to four years.

The evidence for emissions trading systems tells a different story. Känzig [4], using high-frequency carbon futures price changes within narrow windows around 114 EU ETS regulatory announcements, documents that a carbon policy shock normalized to increase energy prices by 1 percent leads to a real GDP decline of approximately 0,3 percent, an industrial production decline of nearly 1 percent, and an unemployment increase of 0,15 percentage points. These effects are statistically significant at both 68 and 95 percent confidence levels. The estimated marginal abatement cost exceeds 100 EUR per ton of CO_2, far above the average ETS price during the sample period. General equilibrium channels, rather than direct energy cost effects, account for approximately two-thirds of the aggregate consumption response. This last finding is corroborated at the micro level: Dechezleprêtre, Nachtigall, and Venmans [14] and Colmer et al. [15] find no statistically significant negative effects of the EU ETS on regulated firms’ revenue, profits, or employment. The coexistence of significant aggregate GDP declines and null firm-level effects confirms that the macroeconomic costs of carbon pricing operate primarily through indirect channels — price transmission, wage adjustments, and supply chain effects — rather than through direct impacts on regulated entities.

Känzig and Konradt [5] provide the critical link between these two bodies of evidence by directly comparing carbon tax and ETS effects within a unified econometric framework. They attribute the divergence to four factors: first, carbon taxes generate earmarked revenue that is typically recycled, whereas ETS revenue allocation is less systematic; second, the two instruments differ in sectoral coverage and price transmission; third, ETS create larger cross-border spillovers and leakage effects; and fourth, monetary policy responds differently to the inflationary shocks generated by each instrument. Additionally, Best, Burke, and Jotzo [16], using a panel of 142 countries, find that CO_2 emissions growth is approximately 2 percentage points lower in countries with carbon pricing — providing complementary evidence that these instruments achieve their environmental objectives, even where GDP effects are modest or absent.

Table 2 - GDP Effects by Revenue Recycling Design

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Revenue recycling design	GDP effect estimate	Reduction vs. no recycling	Source
Income and corporate tax cuts (BC)	No significant effect	Full offset	Bernard, Kichian [13]; Yamazaki [11]
Corporate tax cuts — manufacturing (BC)	+0,06% TFP	Net positive	Yamazaki [12]
Income tax recycling (US CGE)	-0,24% GDP	57%	Goulder, Hafstead [10]
Lump-sum rebate (US CGE)	-0,56% GDP	Baseline	Goulder, Hafstead [10]
Labor tax recycling (Russia CGE)	Positive (double dividend)	> 100% (sign reversal)	Orlov, Grethe [18]
Lump-sum compensation (Russia CGE)	-0,63% welfare	Baseline	Orlov, Grethe [18]

Note: BC = British Columbia. "Reduction vs. no recycling" shows the degree to which recycling reduces the negative GDP impact relative to the no-recycling or lump-sum baseline. CGE results are simulation outputs. The 57 percent figure compares -0,24% (recycling) to -0,56% (lump-sum) in Goulder and Hafstead's E3 model

Revenue recycling consistently emerges as the most consequential policy design parameter (see Table 2). Where recycling has been studied, it reduces the negative GDP impact by at least 50 percent relative to lump-sum redistribution or general budget allocation. Goulder and Hafstead [10] show that the GDP loss from a US carbon tax drops from 0,56 percent (lump-sum) to 0,24 percent (income tax recycling) — a 57 percent reduction. In British Columbia, full revenue recycling eliminates the aggregate GDP effect entirely [13]. Orlov and Grethe [18], modeling a Russian carbon tax, find that with labor tax recycling the sign of the GDP effect reverses: from a welfare loss of 0,63 percent to a net gain, consistent with the "weak" version of the double dividend hypothesis originally formalized by Goulder [19]. This result is particularly relevant for Russia, where the effective labor tax burden (including social contributions of approximately 30 percent) creates substantial distortionary costs that carbon revenue could help alleviate.

Table 3 - Structural Economic Indicators of the Russian Federation (2000–2024)

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Indicator	2000	2005	2010	2015	2021	Latest
GDP per capita, PPP (2021 int. $)	20,105	27,657	33,064	35,037	38,638	41,705
Carbon intensity (kg CO_2e/$ PPP)	0,570	0,438	0,370	0,341	0,341	0,330
Energy intensity (MJ/$ PPP)	12,06	9,42	8,42	7,74	8,46	8,46
Renewable energy share (%)	3,5	3,6	3,3	3,2	3,5	3,5
Trade openness (% of GDP)	68,1	56,7	50,4	49,4	50,6	39,5
Industry value added (% of GDP)	33,9	32,6	30,0	29,8	31,8	30,7

Note: source: World Bank WDI. Latest year: GDP per capita and carbon intensity — 2024; energy intensity and RES share — 2021; trade and industry — 2024. OECD carbon pricing score for Russia's energy-use sectors in 2021: 7,7% of the emissions-weighted benchmark [22]. For reference, the average energy intensity among OECD countries is approximately 4,0–4,5 MJ/$ [23], and the average renewable energy share among countries with active carbon pricing is approximately 20 percent, based on the calibration sample described in the Methods section

Table 3 presents Russia's structural economic indicators. Russia's energy intensity of 8,46 MJ per dollar of GDP in 2021 exceeds the OECD average by approximately a factor of two, despite a substantial reduction from 12.06 MJ per dollar in 2000. Carbon intensity has likewise improved, falling from 0,570 kg CO_2e per dollar in 2000 to 0,330 in 2024 — yet remains more than twice the EU average. Most notably, Russia's renewable energy share of 3,5 percent is far below the approximately 20 percent average among countries with active carbon pricing mechanisms, severely limiting short-run substitution possibilities. The OECD carbon pricing score for Russia's energy-use sectors stands at 7,7 percent of the emissions-weighted benchmark — indicating near-total absence of effective carbon pricing [22]. Only in road transport, where fuel excise taxes implicitly price carbon, does the score approach international norms.

Applying the calibrated model to Russia's parameters yields a predicted GDP elasticity of $\varepsilon = -0{,}028 + (-0{,}0065 \times 8{,}46) + (0{,}0008 \times 3{,}5) = -0{,}080$. This value is approximately 1,9 times the sample mean elasticity of -0,043 for the 47 jurisdictions with existing carbon pricing, reflecting Russia's high energy intensity only partially offset by a negligible renewable energy effect. Table 4 presents scenario projections based on this elasticity, cross-checked against independent CGE estimates.

Table 4 - Scenario Simulations: Projected GDP Impact of Carbon Pricing in Russia

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Scenario	Price, $/tCO_2$	Short-run ΔGDP, no recycling	Short-run ΔGDP, with recycling	Long-run ΔGDP, no recycling	Long-run ΔGDP, with recycling
Low	25	-0,4% to -0,5%	-0,2% to -0,3%	-0,2% to -0,3%	-0,1% to -0,2%
Medium (EU ETS)	50	-0,8% to -1,0%	-0,4% to -0,5%	-0,5% to -0,6%	-0,2% to -0,3%
High (Swedish)	100	-1,5% to -2,0%	-0,8% to -1,0%	-0,9% to -1,2%	-0,4% to -0,6%

Note: ranges reflect the heterogeneous elasticity model (lower bound) cross-checked against CGE estimates from Makarov et al. [17] and Orlov and Grethe [18] (upper bound). Long-run impact applies an approximate 40 percent reduction reflecting capital stock adaptation and induced innovation, based on the average ratio of long-run to short-run estimates across studies in Table 1. Revenue recycling applies an approximate 50 percent reduction based on the cross-study evidence from Table 2. EU ETS reference price as of 2024: approximately 66 EUR

The projections in Table 4 are broadly consistent with independent CGE estimates. Makarov, Chen, and Paltsev [17], using the MIT EPPA model, estimate that sustained global climate policies would reduce Russian GDP growth by approximately 0,5 percentage points annually, with the primary transmission channel being reduced global demand for Russian fossil fuel exports. Orlov and Grethe [18], modeling a domestic Russian carbon tax, find welfare losses of 0,63 percent without revenue recycling but a net welfare improvement with labor tax recycling. Dzyuba [21], in a comprehensive review of CGE models built for the Russian economy, confirms that all reviewed studies project negative welfare consequences from environmental fiscal instruments, but emphasizes that these consequences can be substantially mitigated through targeted investment policies and economic diversification. Our simulation adds to this literature by providing ranges that integrate the meta-analytically derived revenue recycling adjustment with CGE-based estimates — yielding a projected GDP impact at 50 dollars per ton of approximately minus 0,4 to minus 0,5 percent with revenue recycling, compared to minus 0,8 to minus 1,0 percent without it.

Discussion

The central finding of this review is that the macroeconomic impact of carbon pricing depends more on policy design than on price level. The apparent contradiction between studies finding zero GDP effects and those documenting significant output declines dissolves once the instrument type and revenue utilization are accounted for. Carbon taxes with revenue recycling through reductions in distortionary taxes represent a fundamentally different policy intervention than cap-and-trade systems where revenue allocation is uncertain, delayed, or directed toward general government expenditure. This distinction has immediate practical implications: for economies contemplating the introduction of carbon pricing, a revenue-neutral carbon tax is the instrument most likely to achieve emissions reductions while preserving macroeconomic stability.

The Russian case illustrates the stakes involved. With an estimated GDP elasticity approximately twice the average for carbon-pricing countries, Russia faces substantially larger adjustment costs than early adopters of carbon pricing. At the same time, Russia's high labor tax burden creates an unusually large reservoir of distortionary costs that carbon revenue could offset, making the double dividend more achievable than in economies with more efficient tax systems, as Orlov and Grethe [18] demonstrate formally in a CGE framework. Our scenario analysis projects that at a carbon price of 50 dollars per ton, the difference between a non-recycling and a recycling implementation is on the order of 0,4 to 0,5 percentage points of GDP — a substantial economic magnitude equivalent to several billion dollars annually at current Russian GDP levels.

The findings also speak to the broader empirical puzzle regarding firm-level versus aggregate effects. Dechezleprêtre et al. [14] and Colmer et al. [15] find no negative effects on regulated EU ETS firms, while Känzig [4] documents significant aggregate GDP declines from the same policy. This coexistence is explained by the finding that approximately two-thirds of the aggregate consumption response to carbon pricing operates through indirect general equilibrium channels — price transmission, wage adjustments, and supply chain effects — that are invisible in firm-level difference-in-differences designs. This underscores the importance of macro-level evidence for policy evaluation and cautions against extrapolating from micro-level null results to aggregate welfare conclusions.

Several limitations merit acknowledgment. First, the synthesis is necessarily narrative rather than statistical, as ten studies — each employing different methods, samples, and effect definitions — do not provide sufficient degrees of freedom for formal meta-regression. The patterns we identify are consistent across studies but cannot be assigned conventional statistical significance at the meta-level. Second, the heterogeneous elasticity model is a linear approximation that abstracts from nonlinearities, threshold effects, and feedback mechanisms. Its R^2 of 0,41 indicates that more than half the cross-jurisdictional variation in elasticity remains unexplained by energy intensity and renewable energy share alone. Third, the Russian simulation is based on model extrapolation from economies with active carbon pricing to one without it. Russia has not implemented comprehensive carbon pricing, and our projections cannot be validated against observed outcomes. Natural experiments in other carbon-intensive economies (Kazakhstan's ETS, launched in 2013, or South Africa's carbon tax, introduced in 2019) could provide valuable validation evidence as data accumulate. Fourth, our framework focuses on aggregate output effects and does not address distributional consequences across regions, industries, or household income groups. Känzig [4] demonstrates that lower-income households bear disproportionate costs from carbon pricing, suggesting that even revenue-neutral implementations may require additional compensatory mechanisms.

Conclusion

This study has presented the first systematic synthesis of empirical evidence on the macroeconomic effects of carbon pricing, drawing on ten studies spanning local projections, structural vector autoregressions, vector autoregressions, difference-in-differences, panel econometrics, and computable general equilibrium models. Four principal conclusions emerge.

First, carbon taxes with revenue recycling show no statistically significant negative effect on GDP across all econometric studies reviewed. This consensus — spanning European carbon taxes and British Columbia’s revenue-neutral implementation — challenges the prevalent assumption of an inevitable growth-environment tradeoff. Second, emissions trading systems generate larger and statistically significant GDP declines, on the order of 0,3 percent for a shock normalized to a 1 percent energy price increase. The divergence is attributable to differences in revenue recycling, sectoral coverage, price volatility, and monetary policy interactions. Third, revenue recycling is the single most consequential design parameter, reducing negative GDP impacts by 50 percent or more across all settings where it has been studied. This finding validates the “weak” double dividend hypothesis and argues strongly for earmarking carbon pricing revenues for reductions in distortionary taxation. Fourth, Russia’s structural characteristics — energy intensity approximately twice the OECD average and a renewable energy share far below that of carbon-pricing economies — imply adjustment costs approximately double those experienced by early adopters, but revenue recycling through labor tax reductions could reduce the projected impact at 50 dollars per ton of CO_2 from approximately 0,8–1,0 percent to 0,4–0,5 percent of GDP.

For policymakers in carbon-intensive economies, these findings suggest a clear design hierarchy: a carbon tax is preferable to an ETS on macroeconomic grounds; revenue neutrality through distortionary tax reduction is essential; phased introduction (beginning at 10 to 15 dollars per ton and rising predictably) allows capital stock adjustment; and implementation during economic expansion minimizes adaptation costs. For the research community, the absence of a formal meta-regression of GDP effects represents both a limitation of the current study and an opportunity: as the empirical base continues to grow with new natural experiments and longer time horizons, quantitative meta-analysis will become feasible. The integration of household-level distributional analysis, region-specific labor market effects, and long-run innovation dynamics into the macroeconomic assessment framework constitutes the most pressing direction for future research.

Конфликт интересов

Не указан.

Рецензия

Все статьи проходят рецензирование. Но рецензент или автор статьи предпочли не публиковать рецензию к этой статье в открытом доступе. Рецензия может быть предоставлена компетентным органам по запросу.

Conflict of Interest

None declared.

Review

All articles are peer-reviewed. But the reviewer or the author of the article chose not to publish a review of this article in the public domain. The review can be provided to the competent authorities upon request.

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